Disorders of the Hip

- Pain
- Stiffness
- Limp
- Deformity

References:
Anatomy & Physiology

Angle of Inclination: 120-135°
- coxa vara < 120°
- coxa valga > 135°

Muscles
- flexor
  - iliopsoas
- extensor
  - gluteal maximus
- abductor
  - gluteus minimus & medius
- adductor
  - adductor longus, brevis and magnus, and gracilis

Blood supply
History Taking
Physical Examination of the Hip

- Inspection, gait
- Palpation
- Range of motion (active & passive)
- Neurologic examination
  - sensory (dermatome)
  - motor
- Tests (signs)
- Referred pain

Figure 1. The Normal Gait Cycle.
Phase 1
Initial contact
Loading response
Mid stance
Terminal stance
Pre-swing
Terminal swing
Initial swing
Mid swing
Terminal swing

STRIDE

STANCE

SWING

WEIGHT ACCEPTANCE

SINGLE LIMB SUPPORT

LIMB ADVANCEMENT

INITIAL CONTACT
LOADING RESPONSE
MID STANCE
TERMINAL STANCE
PRE SWING
INITIAL SWING
MID SWING
TERMINAL SWING
Fig. 14. An abduction, or gluteus medius, lunch.

Fig. 15. An extensor, or gluteus maximus, lunch.

Fig. 7. By trying to avoid a painful component of gait, a patient walks with an antalgic gait.

Fig. 19. Compensation in gait for a fused joint.

Fig. 20. A fused knee may force the patient to hike his hip so that the foot can clear the floor.

Fig. 9. Weak quadriceps cause the knee to be unstable at heel strike, and the patient may have to push his knee manually into extension.
**Sciatic Stretch Test**

Fig. 54.5  Sciatic stretch test: In the straight-leg-raising test, the leg is lifted with the knee extended. Sciatic roots are tightened over a herniated disc between 30° and 70°. Dorsiflexion of the foot increases pain with nerve impingement.

**The Thomas Test**

Fig. 58.9  The Thomas test. A flexion deformity of the hip is masked by an increased lumbar lordosis (1). Flexion of the contralateral hip flattens the lordosis and reveals the flexion deformity of the hip (2).
FIGURE 10-4. Patrick's test (Faber or Figure-4 test) for the detection of limitation of motion in the hip. (From Beetham, W. P., et al.: Physical Examination of the Joints. Philadelphia, W. B. Saunders Co., 1965, p. 139.)
FIGURE 10-34. Dermatomes around the hip. Only one side is illustrated.

FIGURE 10-36. Referred pain around the hip.
Other Diagnostic Studies

- Plain roentgenography
- Arthrography
  - invasion
  - sedation or anaesthesia
- CT
  - a minimum of radiation exposure
- USG
- MRI
- Arthroscopy

Arthroscopy of the Hip

- **Portals**
- **Indications**
  - labral symptoms, buckling, locking, falling episodes, and persistent inguinal pain unresponsive to conservative treatment
- **Contraindications**
  - ankylosis of the hip and superficial skin infections around the hip
  - (relative) advanced avascular necrosis of the femoral head, advanced osteoarthritis, and congenital dislocation of the hip.
- **Complications**
  - sciatic nerve and the femoral artery and nerve injury
  - transient neuropraxias (sciatic, femoral, and peroneal)
    - a well-padded perineal post
    - minimal amount of traction to allow 8 mm of joint distraction
    - limiting the duration of distraction to 2 hours
  - scuffing of the articular surfaces
  - instrument breakage
  - infection
  - lacerations to the lateral femoral cutaneous nerve

Figure 25-A-11
The setup for hip arthroscopy. ASIS, anterior superior iliac spine.

Figure 25-A-13
Portal placement for hip arthroscopy.

Figure 48-62
Diagram of arthroscopic incisions around hip joint and their relationship to nerves in vicinity. Femoral nerve is too medial to depict in this diagram.
**Developmental Dysplasia of the Hip (DDH)**

- **Incidence**
  - some degree of hip instability: 1/100 to 1/250 babies
  - actual dislocated or dislocatable hips: 1 to 1.5/1000 live births
  - late presentation of DDH: 4/10000 children

- **Etiology**
  - causes unknown?

- **Symptoms & signs**

- **Risk factors**

- **Radiographs**

- **Arthrography**

- **USG**

- **Treatment**
  - conservative
  - surgical

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Figure 27-36 Bilateral untreated congenital dislocation of hip in 12-year-old girl.
**Etiology of DDH**

- **Teratologic dislocations**
  - dislocate early during the course of fetal development will have extreme anatomic abnormalities

- **Risk (factors: female gender, family history, and breech)**
  - 34% in identical twins, but only 3% in fraternal twins
  - 6% to 7% in siblings, one parent and one sibling rise the risk of subsequent infants to 36%

- **Genetic**

- **Breech position**
  - 20% in frank breech position (knees in the extended position)

- **Intrauterine crowding**
  - oligohydramnios, congenital recurvatum or dislocation of the knee, and congenital muscular torticollis

- **Societies**
  - infants are customarily strapped or swaddled (hips extended) with the thighs adducted

- **Certain neuromuscular conditions and genetic syndromes**
  - decreased or abnormal fetal movement
  - arthrogryposis and spina bifida
Recognition of Congenital Dislocation of Hip

Ortolani's (reduction) test
With baby relaxed and content on firm surface, hips and knees flexed to 90°. Hips examined one at a time. Examiner grasps baby's thigh with middle finger over greater trochanter and lifts thigh to bring femoral head from its dislocated posterior position to opposite the acetabulum. Simultaneously, thigh gently abducted, reducing femoral head into acetabulum. In positive finding, examiner senses reduction by palpable, nearly audible "clunk."

Barlow's (dislocation) test
Reverse of Ortolani's test. If femoral head is in acetabulum at time of examination, Barlow's test is performed to discover any hip instability. Baby's thigh grasped as above and adducted with gentle downward pressure. Dislocation is palpable as femoral head slips out of acetabulum. Diagnosis confirmed with Ortolani's test.

Clinical Findings in Congenital Dislocation of Hip
(If untreated, signs become more obvious with growth and weight bearing)

Limitation of abduction due to shortened and contracted adductor muscles of hip

Telescoping, or pitting, action of thigh can be elicited because femoral head not contained within acetabulum

Shortening of thigh with bunching up of soft tissues and excoriation of skin folds

Allis' or Galeazzi's sign
With knees and hips flexed, knee on affected side lower because femoral head lies posterior to acetabulum in this position

Trendelenburg's test
Left: child with congenital dislocation of hip stands on both feet, hips and brim of pelvis are approximately level, except for slight shortening of thigh on affected left side. Right: child stands with weight on affected side; normal right hip drops down, indicating weakness of abductor muscles of left hip.
**Imaging for DDH**

- **USG**
  - **routine screening** - neither cost effective nor practical
  - **3 to 4 weeks** after birth
  - reassessed in **2 to 3 months**

- **Plain radiographs**
  - **routine** - unnecessary
  - femoral head ossification begins by age 6 months: appearance delayed & development stunted
  - proximal femur: lateral lying & proximal migration
  - Shenton line: disrupted
  - acetabulum: fails to develop (increase in the slope of the acetabular roof)

- **CT**
- **MRI**
- **Arthrography**
**Treatment for DDH**

- **Abduction splinting**
  - younger than 6 months of age
  - Pavlik harness
    - hyperflexed - femoral nerve palsy or inferior hip dislocation
    - posteriorly subluxated position - a failure of development of the posterior wall of the acetabulum (Pavlik disease)
    - maximal abduction - ischemic necrosis

- **Closed reduction**
  - older than age 6 months, up to about age 2 years
  - ischemic necrosis, in the human position (hips flexed 100°, abducted 45° and neutrally rotated)

- **Open reduction**
  - older than 2 years of age
  - femoral shortening,
  - pelvic osteotomy

- **Upper age limits**
  - bilateral pain-free dislocation not be reduced after age 6 or 7 years
  - reduction of unilateral dislocations until adolescence
Figure 27-7 A, Developmental dislocation of left hip in 5-month-old girl. B, Intraoperative arthrogram of irreducible left hip showing excessive pooling of dye. C, Same patient at age 4 years; note mild residual acetabular dysplasia of left hip. D, Arthrogram of right hip of 18-month-old girl with irreducible dislocation, capsular constriction, and hypertrophied labrum.

Figure 27-11 A, Anteroposterior roentgenogram of pelvis obtained with patient in spica cast after closed reduction. Note difficulty in assessing position of femoral head. B, CT scan of pelvis to confirm bilateral reduction of femoral head into true acetabulum.
Figure 27-2 Clinical signs of congenital dislocation of hip in 13-month-old girl. A, Decrease in abduction of right hip with adduction contracture. B, Asymmetrical skin fold with difference in levels of popliteal and gluteal skin clefts. C, Positive Galeazzi sign with apparent shortening of right lower extremity.
**Device for Treatment of Clinically Reducible Dislocation of Hip**

- **Pavlik harness**
  - Harness adjusted to allow comfortable abduction within safe zone. Forced abduction beyond this limit may lead to avascular necrosis of femoral head. Posterior strap serves as checkrol to prevent hip from adducting to point of redislocation.

- **Zone of redislocation (adduction)**
  - Safe zone (of Ramsey)
  - Comfortable abduction limit
  - Maximal abduction

Some infants have adductor tightness that prevents reduction, and safe zone becomes narrower. In many cases, adductor musculae relax and hip spontaneously reduces after 2 weeks of wearing harness. If not, traction, and possibly adductor tenotomy, required prior to reduction under anesthesia.

**Positioning Devices Used in Treatment of Congenital Dislocation of Hip**

- **Triple diapers** (one disposable diaper under two cloth diapers)
- **Craig or lifeld splint**
- **Frejka pillow**
- **von Rosen splint**
Figure 27-3 A, Thirteen-month-old child with congenital dislocation of left hip. B, Roentgenographic signs of congenital hip dislocation. 1, Horizontal Y line (Hilgenreiner line). 2, Vertical line (Perkins line). 3, Quadrants (formed by lines 1 and 2). 4, Acetabular index (Kleinberg and Lieberman). 5, Shenton line. 6, Upward displacement of femoral head. 7, Lateral displacement of femoral head. 8, U figure of teardrop shadow (Kohler). 9, Y coordinate (Ponseti). 10, Capital epiphyseal dysplasia: (a) delayed appearance of center of ossification of femoral head, (b) irregular maturation of center of ossification. 11, Bifurcation (furrowing of acetabular roof in late infancy (Ponseti). 12, Hypoplasia of pelvis (ilium). 13, Delayed fusion (ischiopubic juncture). 14, Absence of shapely, defined, well-ossified acetabular margin, caused by delayed ossification of cartilage of roof of socket. 15, Femoral shaft-neck angle. 16, Adduction attitude of extremity. 17, Development of epiphyses of other joints (knee, wrists, and lumbosacral spine). 18, Radiolucent acetabular roof, limbus, joint capsule (arthrographic studies).
Figure 27-6 A, Developmental dislocation of hip in a 2-month-old boy. B, At 5 months of age after reduction in Pavlik harness.

Figure 27-5 Properly applied Pavlik harness.

Figure 27-4 Superior and medial gaps described by Brien et al. to predict treatment outcome. Superior gap is defined as distance between center of femoral head metaphysis and Hilgenreiner's line. Medial gap or lateralization is defined as distance between calcar of femur and lateral pelvic wall at that level.

Figure 27-8 “Safe zone” used to determine acceptability of closed reduction of congenital dislocation of hip.
Figure 27-10 Technique of application of spica cast for congenital dislocation of hip. Note positioning of patient in “human” position (hips flexed 100°, abducted 45° and neutrally rotated).

Figure 27-13 Anteromedial open reduction. A, Bilateral congenital dislocation of hip in 32-month-old girl. B, At age 12 years, normal development of femoral head and acetabulum bilaterally.
Complications of DDH

- **Redislocation**
  - repeat closed reduction or open reduction
  - inadequate inferior capsular release, inadequate capsulorrhaphy, and posterior instability from combined pelvic and femoral osteotomies

- **Ischemic necrosis**
  - excessive or forceful abduction, previous failed closed treatment, and repeat surgery
  - failure of appearance or growth of the ossific nucleus 1 year after reduction, broading of the femoral neck 1 year after reduction, increased density and then fragmentation of the ossified femoral head, or residual deformity of the femoral head and neck after ossification

- **Late dysplasia**
  - femoral, pelvic, or concomitant osteotomy
  - pelvic
    - **reconstructive types**
      - single innominate osteotomy (Salter), triple osteotomy (Steel or Tonnis), periacetabular osteotomy (Bernese), reshaping osteotomy (Pemberton or Dega)
    - **salvage types**
      - Chiari innominate osteotomy and various shelf acetabular augmentations
### Recommended Osteotomies for DDH

<table>
<thead>
<tr>
<th>Osteotomy</th>
<th>Age</th>
<th>Indications</th>
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<tr>
<td>Salter innominate osteotomy</td>
<td>18 mo-6 yr</td>
<td>Congruous hip reduction; &lt;10-15 degrees correction of acetabular index required</td>
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<tr>
<td>Pemberton acetabuloplasty</td>
<td>18 mo-10 yr</td>
<td>&gt;10-15 degrees correction of acetabular index required; small femoral head, large acetabulum</td>
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<tr>
<td>Dial or Steel osteotomy</td>
<td>Skeletal maturity</td>
<td>Residual acetabular dysplasia; symptoms; congruous joint</td>
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<tr>
<td>Shelf procedure or Chiari osteotomy</td>
<td>Adolescent—skeletal maturity</td>
<td>Incongruous joint; symptoms; other osteotomy not possible</td>
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Figure 27-15 A, Teratological dislocation of left hip in 18-month-old girl. B, Appearance at 3 years of age after primary femoral shortening, anterior open reduction, and innominate osteotomy.

Figure 27-18 Primary femoral shortening for congenital dislocation of hip. A, Congenital dislocation of hip in 3-year-old child. B, After anterolateral open reduction. C, Appearance of hip at 6 years of age.
Figure 27-21 Technique for open reduction, primary femoral shortening, and Salter osteotomy. A, Femoral head is dislocated. Gluteal muscles (a) are retracted and slightly shortened. Iliopsoas muscle (b) is intact. Capsule is interposed between femoral head and ilium. Segment of femur is resected. B, Proximal femur is abducted, iliopsoas tendon (b) is divided. Capsule is incised on inferior surface parallel to femoral neck. C, Operation is complete. Gluteal muscles (a) are tight. Iliopsoas muscle (b) is reattached. Salter osteotomy is completed with graft in place. Femoral fragments are fixed with pediatric hip screw.

Figure 27-23 Salter osteotomy for congenital dislocation of hip. A, Residual acetabular dysplasia and subluxation of right hip in 4-year-old girl in whom open reduction had been performed at age of 9 months. B, One year after repeat open reduction and Salter innominate osteotomy.
Figure 27-25 **Pemberton acetabuloplasty.** A, Symptomatic residual acetabular dysplasia in 8-year-old girl after treatment of congenital dislocation of right hip. B, After Pemberton acetabuloplasty.

Figure 27-26 **Pemberton pericapsular osteotomy.** A, Line of osteotomy beginning slightly superior to anteroinferior iliac spine and curving into triradiate cartilage. B, Completed osteotomy with acetabular roof in corrected position and wedge of bone impacted into open osteotomy site.
Figure 27-27 **Steel triple innominate osteotomy.** A, Sixteen-year-old girl with painful right hip, subluxation, and acetabular dysplasia. B, After Steel osteotomy. C, One year after surgery.

Figure 27-28 **Steel triple innominate osteotomy.** A, Osteotomies to be performed in iliac wing and superior and inferior pubic rami. Note wedge of bone to be taken as graft from most superior portion of ilium. B, Lateral view showing graft in place and fixation with two Kirschner wires.
Figure 27-30 **Dega osteotomy.** A, Skin incision. B, Osteotomy line is marked on lateral cortex of ilium; guide wire is inserted to exit just above horizontal limb of triradiate cartilage. C, Osteotome penetrates inner cortex. D, View from inner side of pelvis shows intact posteromedial cortical hinge; the length of the intact inner cortex depends on the amount of anterior and lateral coverage desired. E, Osteotomy is levered open with osteotome or small laminar spreader. F, Two grafts large enough to keep osteotomy open at premeasured height are inserted. G, Larger graft is inserted anteriorly; posterior graft should be smaller to avoid loosening the anterior graft.

Figure 27-29 Before (A) and after (B) **Dega transiliac osteotomy.**
Figure 27-32 **Slotted acetabular augmentation of Staheli.**
A, Width of augmentation, $WA$, is determined preoperatively from standing anteroposterior roentgenogram of pelvis. CE angle and 35-degree angle are drawn. Graft length, $gl$, is sum of $WA$ and slot depth. 
B, Objective of procedure is to provide congruous extension of acetabulum. C, Details of extension.

Figure 27-33 **Staheli slotted acetabular augmentation.**
A, Fourteen-year-old girl with **painful right acetabular dysplasia.** B, Four months after operation. C, One year after operation, excellent graft incorporation.
Figure 27-34 Chiari osteotomy. A, Young adult with painful, bilateral acetabular dysplasia, greater on left than on right. B, After Chiari osteotomy of left hip. Note optional internal fixation and medial bone grafting. C, Bilateral acetabular dysplasia in 12-year-old girl. D, After surgery, right hip is completely displaced. E, One year after Chiari osteotomy.

Figure 27-35 Chiari medial displacement osteotomy. A, Line of osteotomy extending from immediately superior to lip of acetabulum into sciatic notch. Osteotomy can be curved to facilitate femoral head coverage. B, Completed osteotomy with medial displacement of distal fragment for interpositional capsular arthroplasty.
**Coxa Vara**

Angular relation between the femoral head or neck, or both, and the femoral shaft, which is less than the normal value for the patient’s age.

- **Congenital**
  - Detectable at birth
  - Accompanied by shortening of the proximal femur

- **Developmental**

- **Acquired**

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**Figure 27-37 Congenital coxa vara.** A, Two-year-old girl with congenital coxa vara. B, Preoperative roentgenogram shows neck-shaft angle of less than 90 degrees bilaterally at age 5 years. C, After bilateral subtrochanteric osteotomies and internal fixation with pediatric hip screw.
Developmental Coxa Varus

1/25000 live births
- Male = female, right = left, bilateral in 50% (30%)
- Underlying defect unknown?
  - an unspecified primary ossification defect in the inferior femoral neck
  - physiological stresses of weight bearing
  - MRI and some biopsy specimens support
- An waddling, Trendelenburg gait
  - hip abductors are functionally weakened

AP radiograph
- anatomic coxa vara
- widened vertically oriented physeal plate
- shortened neck normal straight femoral shaft
- separate triangular ossification center (irregular & fragmented) on the inferior part of the femoral neck

Figure 5 Hilgenreiner's physeal angle is created by a line through the triradiate cartilage and its intersection with a line through the phys. The normal angle is about 25°. (Reproduced with permission from Beals RK. Coxa vara in childhood: Evaluation and management. J Am Acad Orthop Surg 1998;6:93-99.)
Hilgenreiner’s (Epiphyseal) Angle

- < 25° - normal
- < 45° - spontaneous healing
- > 60°

- progression of the coxa vara, stress fracture and nonunion of the femoral neck, and early degenerative arthritis of the hip
- surgical derotational valgus-producing osteotomy of the proximal femur
Slipped Capital Femoral Epiphysis (SCFE)

**Etiology**
- unknown?
- 50% above the 95th percentile, obese
  - younger than 10 years of age or 16 years and older
  - below the 50th percentile

**Epidemiology**
- prevalence in the USA between 2 to 10/100000 children
- male : female = 3:2 (2.5:1), mean age for diagnosis 13.5 years for boys (10 to 16) and 12 (11.5) years for girls (10 to 14), left : right = 2:1, 25% (17% to 50%) bilateral
- summer and fall months
- half the children who have bilateral hip involvement are identified at the time of initial presentation

**Diagnosis**
- 85% hip or proximal thigh pain and 15% only knee pain
- a paradoxical limp - lean over the extremity during the stance phase (localize the cause of pain)
- hallmark of PE - flexes the hip, the patient’s leg will externally rotate obligatorily (complete loss of internal rotation and pain)
**Slipped Capital Femoral Epiphysis**

- **Radiography**
  - confirmed with AP and “frog-lateral” (should be avoided with acute slips) hip radiographs
  - the earliest radiographic sign - growth plate widening or lucency (epiphysiolysis)
  - chronic slips - a radiodense blush sign on the metaphyseal side of the capital femoral growth plate
  - the lateral edge of the femoral head may not project over the Klein’s line (a line drawn up along the superior border of the femoral neck)

- **Clinical classification**
  - stable
    - walk into the examiner’s office with or without crutches
  - unstable
    - difficulty with ambulation and usually presents on a gurney or in a wheelchair
    - osteonecrosis of the femoral neck

- **Treatment**
  - the most popular treatment is single screw fixation across the capital femoral growth plate performed in situ (without reduction) in stable slips
Slipped Capital Femoral Epiphysis

Frog-leg radiograph, which demonstrates slipped epiphysis more clearly, always indicated when disorder is suspected.

Pin Fixation in Slipped Capital Femoral Epiphysis

Pins enter at anterior aspect of base of femoral neck outside joint capsule, are directed postero-medially to remain within neck and engage epiphysis of femoral head.

Posterior view shows how pins placed incorrectly through lateral cortex exit neck and reenter head, with risk of damaging vessels along neck.

Radiograph shows pins crossing joint space, which may damage surface of acetabulum. Pin position must be checked on both antero-posterior and frog-leg radiographs.

Classification

Grade I (<33%)
Grade II (33%-50%)
Grade III (>50%)

Antero-posterior view

Frog-leg view

Pin with flat, diamond-shaped tip (above) difficult to remove after bone growth. Trocar-pointed pin (below) easier to remove.
Legg-Calvé-Perthes Disease (LCPD)

<idiopathic osteonecrosis of the femoral head (ossific nucleus) in children>

- 4 to 8 Y/O (2 Y/O - late teen-age years)
- Boys : girls = 4:1 (3-5:1)
- 10% to 12% bilateral

Epidemiology
- positive family history (10%)
- breech or transverse lie
- racial & ethnic
- lower birth weight
- delay in skeletal maturation
- short stature (affected at an older age)
- later-born children (third to 6th child)
- lower socioeconomic groups
- G-U tract abnormalities
- inguinal hernia
- minor congenital abnormalities
Histologic Changes of LCPD [1913 Perthes]

- Superficial zone of the cartilage covering the affected femoral head is normal but thickened.
- Middle layer of the epiphyseal cartilage, two types of abnormalities:
  - areas of extreme hypercellularity, with the cells varying in size and shape and often arranged in clusters.
  - in other areas, a loose fibrocartilaginous-like matrix.
- Physeal plate shows evidence of cleft formation with amorphous debris and extravasation of blood.
- Metaphyseal region, proliferating cells are separated by a fibrillated cartilaginous matrix that does not calcify.
Legg-Calvé-Perthes Disease

- **Symptoms & signs**
  - insidious onset of a limp
  - activity related pain and rest by rest
  - limited hip motion (abduction & medial rotation)
  - positive Trendelenburg test
  - thigh, calf and buttock atrophy
  - inequal limb length (head collapse) - poor prognosis

- **Radiography**
  - AP and frog-leg lateral

- **Radionuclide bone scanning**

- **MRI with gadolinium enhancement**

- **Differential diagnosis**
  - transient synovitis
  - septic arthritis
  - primary or secondary to proximal femoral osteomyelitis
Physical Examination in Legg-Calvé-Perthes Disease

Limitation of internal rotation of left hip. Hip rotation best assessed with patient in prone position because any restriction can be detected and measured easily.

"Roll" test for muscle spasm. Patient relaxed and supine on table. Examiner places hands on limb, gently rolls hip into internal and external rotation, noting resistance.

Thomas' sign
Hip flexion contracture determined with patient supine. Unaffected hip fixed only until lumbar spine is flat against examining table. Affected hip cannot be fully extended, and angle of flexion is recorded. 15° flexion contracture of hip is typical of Legg-Calvé-Perthes disease.

Trendelenburg's test
Left: patient demonstrates negative Trendelenburg's test of normal right hip. Right: positive test of involved left hip. When weight is on affected side, normal hip drops, indicating weakness of left gluteus medius muscle. Trunk shifts left as patient attempts to decrease biomechanical stresses across involved hip and thereby maintain balance.

Determination of atrophy of proximal thigh. Circumference of each upper thigh measured at most proximal level, and difference noted.

Test for limitation of abduction. Patient supine and relaxed on table. Legs gently and passively abducted to determine range of motion of each.
Legg-Calvé-Perthes Disease

- Cause unknown? controversy (an inherited thrombophilia? a resistance to activated protein C promotes thrombotic venous occlusion in the femoral vein causing bone death in the femoral head?)

- Differentiating an irritable hip with transient synovitis
  - irritable hip syndrome occurs twice in boys, whereas Legg-Calvé-Perthes disease occurs three times in boys
  - the average age with irritable hips is 3 years, and the average age with Legg-Calvé-Perthes disease is 7 years
  - irritable hips have an average duration of symptoms of 6 days, whereas Legg-Calvé-Perthes diseases have symptoms present for an average of 6 weeks

- Using ultrasound evaluation
  - transient synovitis with capsular distension caused by synovial effusion and Legg-Calvé-Perthes disease with thickening of the synovial membrane
  - capsular distention persisting longer than 6 weeks associated with the onset of Legg-Calvé-Perthes disease
  - more than 2 years' delay in their bone age in the early phases of Perthes disease, a plain wrist roentgenogram

- Plain roentgenographic changes are delayed 6 weeks or more, bone scintigraphy and MRI can establish the diagnosis much earlier
**Stages/Pathogenesis of LCPD**

<stages are based on radiographs>

- **Initial ischemic stage**
  - occult for the first 3 to 6 months

- **Fragmentation stage**
  - femoral head appears to fragment or dissolve, either partially or totally
  - revascularization as the infarcted bone is resorbed, leaving behind a lucent zone in the femoral head

- **Reossification stage**
  - new bone appears

- **Healing stage**
  - femoral head reossifies back to normal bone density
  - residual femoral head and neck deformity including shortening (coxa breva), widening (coxa magna), and flattening may exist
Radiographic Findings of LCPD

- An apparent joint space widening (the earliest findings)
- Failure of the involved femoral ossific nucleus to grow
- Irregularity and increased density of the femoral head ossification center
- A subchondral radiolucent line (crescent sign)
  - < ½ the femoral head is Salter-Thompson class A
  - > ½ the femoral head is Salter-Thompson class B
- The extent of fragmentation of the ossific nucleus
  - **Catterall classification**
    - < ½ the femoral head is stages 1 and 2
    - > ½ the femoral head is stages 3 and 4
  - **Herring lateral pillar classification**
    - Based on the height of the lateral pillar of an AP hip radiograph obtained approximately at the start of the fragmentation phase
    - group A, no involvement of the lateral pillar
    - group B, at least 50% of lateral pillar height maintained
    - group C, less than 50% of lateral pillar height maintained

![Figure 29-20 Lateral pillar classification based on height of lateral pillar.](image)
Catterall and Salter-Thompson Classifications and Corresponding Radiographs

A. Antero-posterior radiograph of 7-year-old boy shows Catterall group 1 involvement

B. Frog-leg radiograph

C. Antero-posterior radiograph, 7 months later

D. Frog-leg radiograph

E. Antero-posterior radiograph of 7-year-old boy shows Catterall group 2 involvement

F. Frog-leg radiograph

G. Antero-posterior radiograph, 6 months later

H. Frog-leg radiograph
**Lloyd-Roberts classification**

<according to the amount of involvement of the capital femoral epiphysis>

- **Group I**, partial head or less than half head involvement
- **Groups II and III**, more than half head involvement and sequestrum formation
- **Group IV**, involvement of the entire epiphysis
Roentgenographic “Head-at-Risk” Signs

- Lateral subluxation of the femoral head from the acetabulum
- Speckled calcification lateral to the capital epiphysis
- Diffuse metaphyseal reaction (metaphyseal cysts)
- A horizontal physis
- Gage sign, a radiolucent $\backslash\backslash$-shaped defect in the lateral epiphysis and adjacent metaphysis
Treatment of Legg-Calvé-Perthes Disease

- Primary aim is containment of the femoral head within the acetabulum, “biological plasticity”
- Containment by femoral varus derotational osteotomy for older children in groups II, III, and IV with head-at-risk signs
- Contraindications include an already malformed femoral head and delay of treatment of more than 8 months from onset of symptoms
- Surgery is not recommended for any group I children or any child without the head-at-risk signs
Conservative Management in Legg-Calvé-Perthes Disease

"Slings and springs" 8-year-old girl with Salter-Thompson group A involvement. Following elimination of hip irritability, range-of-motion exercises instituted to restore function.

Petrie cast 8-year-old boy with group A involvement. Radiograph of right hip shows adequate coverage of femoral head (lateral margin inside perpendicular line through lateral margin of acetabulum).

Toronto brace Allows child to sit with knees flexed. However, compliance better with Petrie cast because cast cannot be removed by patient.

Conservative Management in Legg-Calvé-Perthes Disease (continued)

Atlanta Scottish Rite Children's Hospital brace Permits patient to walk without support. Allows greater hip abduction by means of telescoping bar, and free motion at knee and ankle.

Tachdjian abduction brace Maintains hip in 40° to 45° abduction and prevents adduction, thus keeping femoral head in acetabulum. Also ensures that body weight is kept off avascular femoral head.

Salter stirrup crutch Maintains good coverage of femoral head but requires cooperative patient. Used chiefly to restore hip motion in preparation for surgery.
Indications for Reconstructive Surgery

- Hinge abduction
  - valgus subtrochanteric osteotomy
- A malformed femoral head in late group III or residual group IV
  - Garceau's cheilectomy
- A coxa magna
  - a shelf augmentation
- A large malformed femoral head with subluxation laterally
  - Chiari's pelvic osteotomy
- Capital femoral physeal arrest
  - trochanteric advancement or arrest

Figure 29-21 Innominate osteotomy for Perthes disease. A, Child 7 years of age with bilateral Catterall group III involvement with “head-at-risk” signs of lateral calcification (subluxation) and metaphyseal cyst on left. B, Eight weeks after innominate osteotomy with fixation using three pins. C, Three years after innominate osteotomy. Head is contained without evidence of subluxation. CE angle is 28 degrees, and head is concentric but slightly enlarged.

Figure 29-26 Valgus osteotomy to reduce hinge abduction and increase flexion of hip; osteotomy is fixed with pediatric screw and side plate.
Femoral Varus Derotational Osteotomy

Preoperative view
Femoral head flattened and subluxated, protruding well outside lateral margin of acetabulum. Red lines indicate proposed osteotomy and wedge of bone to be resected.

Postoperative view
Resection of bone wedge has abducted neck and head of femur so that epiphysis is well covered within acetabulum. Broken red line indicates original position. Procedure accentuates limb-length discrepancy.

Innominate Osteotomy

Osteotomy rotates acetabulum, resulting in good coverage of femoral head, as shown by red lines.

Preoperative anteroposterior radiograph shows flattening and protrusion of femoral head.

Aeroposterior radiograph of 8-year-old boy shows Cotterall group 2 (Salter-Thompson group A) involvement in left hip. Subluxation with lateral margin of acetabulum directly over area of resorption. Lateral margin of femoral head no longer provides support.

3 months after varus derotational osteotomy. Anteroposterior radiograph shows subluxation corrected; lateral margin of femoral head within acetabulum and again provides support.

Good coverage of femoral head 6 weeks after innominate osteotomy.

Healed, spherical femoral head (pins removed), 3 years after surgery.
Figure 29-27 Cheilectomy for Perthes disease. A, Roentgenogram of left hip of 7-year-old boy with Perthes disease who had been treated without containment and developed lateral subluxation of femoral head (late group III). B, Same patient in residual stage with coxa plana and lateral protuberance of femoral head outside acetabulum, which caused pain and limited abduction of hip. C, Roentgenogram made during surgery for cheilectomy. Large protruding area of bone has been excised. D, At follow-up several years later pain is relieved and motion, including abduction, is increased. Area of myositis ossificans or calcification is apparent in superior capsule of hip joint.
Figure 29-28 A, Ideal Chiari osteotomy with 15-degree up-slope to obtain coverage in mild hip dysplasia. B, Chiari osteotomy with supplemental graft and shelf for severely dysplastic hip.

Figure 29-29 Chiari osteotomy for residual Perthes disease. A, Anteroposterior and lateral roentgenograms showing residual Perthes disease (coxa plana) and subluxation in hip on right. B, Eight months after Chiari osteotomy with good coverage of femoral head.
Figure 29-30 A and B, Growth of proximal femur; arrows indicate site and direction of growth. C, If growth potential is impaired, **longitudinal growth is arrested** but greater trochanter continues to grow.

Figure 29-32 After initial **osteotomy of the greater trochanter**, trapezoidal wedge of bone is removed.

Figure 29-31 **Trochanteric advancement** for trochanteric overgrowth.
Prognostic Factors of LCPD

- Deformity of the femoral head and hip joint incongruence
- Age of disease onset
- Extent of epiphyseal involvement
- Growth disturbance secondary to premature physeal closure
- Protracted disease course
- Acetabular and femoral head remodeling potential
- Type of treatment
- Stage during which treatment is initiated
A statistically significant correlation between the final outcome (Stulberg classification) and the loss of pillar height:

- Group A had good outcomes
- Group B < 9 years of age at onset had good outcomes, but > 9 years of age had less favorable results
- Group C had the worst results, with aspherical femoral heads, regardless of age at onset

Advantages of this classification:

- Easily applied during the active stages
- High correlation between the lateral pillar height and the amount of femoral head flattening at skeletal maturity, accurate prediction of the natural history and treatment methods
Irritable Hip

Transient Synovitis, Toxic Synovitis, Observation Hip, Coxitis serosa, Coxalgia Fugax

- The most common source of hip pain and limp in the young child (< 10 Y/O, average 5-6 Y/O)
- Cause unknown?
  - recent history of URI (viral, allergic reaction?)
  - history of trauma
- Boys : girls = 2-3:1, right and left equally, 95% unilateral
- Pain or limp, tenderness, pain & limited ROM (abduction & medial rotation), thigh atrophy, antalgic gait, walk with the hip in slight flexion, external rotation and abduction
Differential Diagnosis of Irritable Hip

- Septic arthritis
  - pain, elevated temperature, WBC, ESR, CRP
  - osteomyelitis of the proximal femur
  - blood culture, USG, isotope scan, aspiration & arthrogram

- Rheumatic fever
  - migratory polyarthralgia
  - history of a β-hemolytic streptococcal infection 1 to 3 weeks before the onset of hip pain

- LCPD
  - slight male predominance
  - retardation of bone age
  - may decrease uptake un bone scan of early stage

- Juvenile rheumatoid arthritis

- Slipped capital femoral epiphysis
  - obese adolescent during the growth spurt and typical radiographic features

- Tumors (osteoid osteoma of the proximal femur)
  - history of night pain relieved by aspirin
Treatment of Irritable Hip

<self-limiting, 3 to 7 days (weeks to months)>

- Rest, hospitalization & light skin traction
- Antiinflammatory agents
- Crutch-protected weight bearing with gradual resumption of full weight bearing
Osteochondritis Dissecans of the Hip

- Most frequently after Perthes disease, rarely occurs as an isolated entity
- A higher incidence in hips with worse prognoses
- In children, loose bodies secondary to
  - Perthes disease
  - avascular necrosis of sickle cell disease
  - multiple epiphyseal dysplasia
  have to be ruled out before this diagnosis
- In adults
  - idiopathic avascular necrosis
  - Gaucher disease
  - occult trauma, such as a torn acetabular labrum
  have to be considered in the differential diagnosis
Treatment for Osteochondritis Dissecans

- In children, restrict activity and occasionally brace the hip in the hope that healing and revascularization would occur.
- In an asymptomatic child with osteochondritis dissecans of the hip, restriction of activity and prolonged observation are indicated to allow healing and revascularization.
- Operative treatment for severe lesions with disabling symptoms, depends on:
  - the extent and location of the lesion
  - the age and activity expectations of the patient
  - the presence of degenerative joint changes
- Arthroscopy of the hip:
  - removal of an osteochondritis lesion
  - synovial biopsy
  - removal of loose bodies
  - removal of debris and inspection of the labrum after fracture-dislocation
  - partial or total synovectomy
Figure 29-33 Osteochondritis dissecans of hip. A, Onset of Perthes disease in 6-year-old patient. B, Fourteen months later, fragmentation and reossification stage. C, Persistent defect 5 years after onset. D, Osteochondritic lesion at 7 years with some evidence of healing. E, Lateral roentgenograms during same period show osteochondritic lesion. Note air arthrogram with smooth cartilage surface. F, At 8 years with osteochondritis; defect is healing. G, Lateral roentgenogram at same time shows no evidence of defect.
**Snapping Syndromes of the Hip**

**Snapping hip or coxa saltans**
- an audible and palpable or even visible snap
- a tense fascial band (the thickened posterior border of the iliotibial band or the anterior border of the gluteus maximus muscle near its insertion) catches as it slides over the superior margin of the greater trochanter as the hip is flexed, adducted, or rotated internally
- voluntarily, painless and infrequent, or involuntarily, painful and chronic

**External type**
- involves the greater trochanter and soft tissue structures overlying it

**Internal type**
- involves the iliopsoas tendon and the structures located behind it

**Intraarticular snapping**
- has a variety of causes, including synovial chondromatosis, loose bodies, labral tears, fracture fragments, and habitual subluxation
**Snapping Hip**

- **External type**
  - involves the greater trochanter and soft tissue structures overlying it
- **Internal type**
  - involves the iliopsoas tendon and the structures located behind it
- **Intraarticular snapping**
  - has a variety of causes, including synovial chondromatosis, loose bodies, labral tears, fracture fragments, and habitual subluxation

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Figure 25-A-9 Magnetic resonance arthrogram demonstrating an acetabular labral tear.

Figure 25-A-10 Arthroscopic view of a labral tear before (A) and after (B) débridement.
**External Derangement**

- The thickened posterior border of the iliotibial band or the anterior border of the gluteus maximus muscle near its insertion
- The sliding over the greater trochanter
- Fibrosis of the posterior fibers of the gluteus maximus muscle arising from multiple intramuscular injections, requires surgical treatment
- Rarely requires surgery because usually painless
- Painful, physical therapy, local injections, or activity modification
- Surgery, local anesthesia is preferable to general anesthesia
  - the tense band is difficult to find when the muscles are completely relaxed
  - with local anesthesia the patient can voluntarily snap the hip during surgery, and the band can be located easily by direct vision and palpation

Figure 24-3 Z-plasty of iliotibial band for snapping hip. A, Incision. B, Transposition and suture of flaps.
Internal Derangement

- **Iliopsoas tendon or underlying bursa**
  - With flexion of the hip, the iliopsoas tendon shifts laterally in relation to the center of the femoral head.
  - When the hip is extended, the tendon slides medially across the femoral head.
  - This back and forth motion of the iliopsoas tendon over the head of the femur can produce snapping.

- **Iliopsoas snapping over a prominence of the iliopectineal ridge or an exostosis of the lesser trochanter**

- **Snapping of the iliopsoas tendon over a prominent iliopsoas bursa lying between the tendon and the anterior hip joint capsule**

- **Iliopsoas bursography is the single most useful roentgenographic study to differentiate between the possible internal causes of hip snapping**

- **MRI is useful for excluding intraarticular abnormalities**

- **Prolonged conservative treatment before surgery**
Intraarticular Derangement

- Osteochondromatosis
- Various other loose bodies
- Subluxation of the hip
  - result of abnormalities of the posterior acetabular margin or paralysis of the hip muscles
- An inverted fibrocartilaginous labrum or cartilaginous fragment in traumatic dislocation of the hip
  - a torn labrum within the acetabulum
  - recurrent dislocation of the hip (similar to that of a recurrent shoulder dislocation)
  - reattachment of the labrum and capsule to the acetabulum
- Either a standard anterior or posterior approach to the hip
Osteonecrosis (AVN) of the Femoral Head

- **Incidence**
  - not known
  - males, their late 30s or early 40s
  - 50% bilateral

- **Symptoms & signs**
  - pain in the groin region that is exacerbated with ambulation and activity

- **Etiology**
  - result of altered blood supply to the femoral head
    - result in bone necrosis, subcortical fracture, collapse and eventual destruction of the hip joint
  - includes alcohol abuse, gout, caisson disease, Gaucher disease, renal osteodystrophy, sickle cell anemia, systemic steroid use, and trauma
    - 10% hip trauma, hip dislocation or femoral neck fracture
    - corticosteroidal use, ethanol abuse and hypercoagulable states
    - receiving medical treatment for AIDS are at risk
    - > 1/3 idiopathic
  - hypotheses include direct cellular toxicity, coagulopathic states, hyperlipidemia/fat emboli, vascular interruptions or abnormalities, and elevated bone marrow pressure

- **Radiographs**
- **Bone scintigraphy & MR image**
  - may show changes in the femoral head before plain radiographs

- **Staging**
  - modified version of one proposed by Ficat

- **Treatment**
  - depends on the stage at the time of diagnosis
# Classification of Osteonecrosis of Femoral Head

<table>
<thead>
<tr>
<th>Stage</th>
<th>Symptoms</th>
<th>Roentgenogram</th>
<th>Bone Scan</th>
<th>Pathological Findings</th>
<th>Biopsy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None</td>
<td>Normal</td>
<td>Decreased uptake?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>None/Mild</td>
<td>Normal</td>
<td>Cold spot on femoral head</td>
<td>Infarction of weight-bearing portion of head</td>
<td>Abundant dead marrow cells, osteoblasts, osteogenic cells</td>
</tr>
<tr>
<td>2</td>
<td>Mild</td>
<td>Density change in femoral head</td>
<td>Increased uptake</td>
<td>Spontaneous repair of infarcted area</td>
<td>New bone deposited between necrotic trabeculae</td>
</tr>
<tr>
<td>2A</td>
<td></td>
<td>Sclerosis or cysts, normal joint line, normal head contour</td>
<td>Increased uptake</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2B</td>
<td></td>
<td>Flattening (crescent sign)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Mild to moderate</td>
<td>Loss of sphericity, collapse</td>
<td>Increased uptake</td>
<td>Subchondral fracture, collapse, compaction and fragmentation of necrotic segment</td>
<td>Dead bone trabeculae and marrow cells on both sides of fracture line</td>
</tr>
<tr>
<td>4</td>
<td>Moderate to severe</td>
<td>Joint space narrowing, acetabular changes</td>
<td>Increased uptake</td>
<td>Osteoarthritic changes</td>
<td>Degenerative changes in acetabular cartilage</td>
</tr>
</tbody>
</table>

Figure 25-38 Crescent sign in stage III osteonecrosis.
Treatment of Osteonecrosis of the Hip

Arrest the progression of the disease
Prevent late collapse of the femoral head and the development of progressive degenerative arthritis

Nonoperative
- restricted weight bearing

Operative
- procedures that attempt to salvage the existing femoral head
  - core decompression - stage 1 and 2A (sclerotic)
  - (vascularized) bone grafting
  - (proximal femoral) osteotomy - stage 2A (cystic), 2B or 3 if the invasive segment not too extensive
  - electric stimulation
- reconstructive procedures
  - bipolar hip replacement - stage 3 not amenable osteotomy
  - Hemiresurfacing arthroplasty - stage 3 in younger patients
  - THP - stage 3 in middle-aged and older patients or stage 4
Figure 25-40 **Vascularized fibular grafting** for osteonecrosis of femoral head. A, Anterolateral approach, with dissection between tensor fasciae latae (TFL) and gluteus medius (GMe). Vastus lateralis (VL) is reflected from vastus ridge, and core (16 to 21 mm in diameter) is made in femoral neck to necrotic bone in femoral head. GT, Greater trochanter. B, Necrotic bone is removed from femoral head through core. C, Fibular graft, with peroneal artery (pa) and vein (pv), is harvested from ipsilateral leg. D, Cancellous bone chips from greater trochanter and fibular graft are inserted into core. Kirschner wire (0.062 inch) is used to stabilize fibular graft. Peroneal artery and vein are anastomosed to ascending branches of lateral femoral circumflex artery and vein.

Figure 25-39 **Core decompression and cortical press-fit structural bone grafting** for osteonecrosis of femoral head (stage I or II).
Figure 25-42 Transposition of necrotic focus of femoral head anteroinferiorly away from weight-bearing area as result of anterior rotation of head. A, Before rotation. B, After rotation.

Figure 25-41 Sugioka osteotomy.
OA of the Hip

- Characteristics
- Etiology
- Epidemiology
- Pathology
- Symptoms & signs
- Radiographs
  - nonuniform joint space narrowing
  - cortical sclerosis on the weight-bearing bony surfaces
  - subchondral cyst
  - marginal osteophytes
  - loose bodies and subluxation
- Treatment
  - conservative
  - surgical
RA of the Hip

- Characteristics
- Etiology
- Clinical feature
- Radiologic feature
  - periarticular soft tissue swelling
  - juxtaarticular osteoporosis
  - marginal erosion and cyst
  - uniform loss of joint space
  - marked deformity with subluxation, dislocation, destruction, and fusion

- Pathological feature
- Management
  - conservative
  - surgical